Interface Control Document (ICD) Between the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS)

(Revision 2)

July 7, 1997

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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There are currently no TBDs and TBRs

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Abstract

This Interface Control Document (ICD) presents the functional, performance, operational, and design requirements for the interface between the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS).

This document provides a current understanding of the definition of the interface between the LGS and the LPS. This interface control document has been baselined by the LPS and LGS Projects for developing and implementing the interface between the LGS and the LPS.

Keywords: Interface Control Document (ICD)
Landsat 7 Processing System (LPS)
Landsat 7 Ground Station (LGS)

Preface

This ICD is controlled jointly by the Information Processing Division (IPD) Configuration Control Board (CCB) and the Networks Division CCB and may be updated by Document Change Notice (DCN) or revision. Comments and questions regarding this ICD should be directed to:

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Section 1 — Introduction

1.1 Purpose

This Interface Control Document (ICD) presents the interface requirements between the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS), both located at the EROS Data Center (EDC).

This document is an incorporated part of the LGS Functional and Performance Requirements (F&PR) and the LPS Functional and Performance Specifications (F&PS). The purpose of this document is to provide further detail regarding the requirements for the interfaces described in the LGS F&PR and the LPS F&PS.

1.2 Scope

This document provides details on the functional, performance, operational, and design requirements for the interface between LGS and the LPS. This document is intended for all parties requiring such information, including system engineers and system designers responsible for implementing the interface.

1.3 Interface Responsibilities

Interface responsibilities are defined in terms of the LGS Project (Code 531.2) and the LPS Project (Code 514.1). Interface functional, performance, operational, and design requirements and parameters in this ICD are subject to the bilateral control of the LGS Project (Code 531.2) and the LPS Project (Code 514.1).

Section 2 — Documentation

The following documents provide more detailed information regarding the LPS, the LGS, and the Landsat 7 system. If there are conflicts between the listed documents and the requirements of this ICD, the requirements of this ICD shall be considered to be the superseding requirements.

2.1 Applicable Documents

These documents were used to derive requirements.

1. Consultative Committee for Space Data Systems (CCSDS), Recommendation for Space Data System Standards; Advanced Orbiting Systems (AOS), Networks and Data Links: Architectural Specification, Blue Book, CCSDS 701.0-B-1, Issue 1, October 1989.

2. NASA GSFC/MO&DSD, Landsat 7 Processing System (LPS) Functional and Performance Specification (F&PS), Revision 1, 560-8FPS/0194, July 28, 1995 and DCN 02, July 31, 1996.

3. National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) Landsat 7 Detailed Mission Requirements, May 15, 1995.

4. Martin Marietta Astro Space (MMAS), Landsat 7 System Data Format Control Book (DFCB), Volume 4 - Wideband Data, Revision C, 23007702, April 4, 1996.

5. NASA GSFC/MO&DSD, Landsat 7 Ground System (LGS) Functional and Performance Requirement (F&PR), Review, 531-FPS-GN/Landsat 7, December 1994.
6. NASA GSFC/MO&DSD, Interface Control Document (ICD) between the Landsat 7 Mission Operations Center (MOC) and the Landsat 7 Ground System (LGS), 511-4ICD/0296, April 1997.

2.2 Reference Documents

These documents are used for background information.

1. GSFC/MO&DSD, Systems Management Policy, SMP-500, March 1993.

2. NASA GSFC/MO&DSD, Landsat 7 Processing System (LPS) Operations Concept, Revision 2, 560-3OCD/0194, April 15, 1996.

3. NASA, Landsat 7 Level 1 Requirements, Draft Issue, August 8, 1994.

4. MO&DSD Mission Operations Concept Document for the Landsat 7 Ground System, June 5, 1995.

5. Consultative Committee for Space Data Systems (CCSDS), Recommendation for Space Data System Standards, Telemetry Channel Coding, Blue Book, CCSDS 101.0-B-3, May 1992.

6. Santa Barbara Research Center (SBRC), L-7 Auxiliary Electronics Module (L-7 AEM) Development Specification, 150117/B, June 1994

7. NASA GSFC/MO&DSD, Landsat 7 Ground System (LGS) Operations Concept, Pre-CCB version, 430-11-06-003-0, November 1994.

Section 3 — Interface Description

LGS and LPS are major components of the Landsat 7 system. Both the LGS and LPS are located at the Earth Resources Observation System (EROS) Data Center (EDC). Figure 3-1 provides an overview of the LGS and LPS and the wideband data transfer interface between them.

3.1 LGS Description

The LGS is responsible for acquiring the ETM+ wideband data directly from the Landsat 7 spacecraft via two of three 150 Mbps X-band downlinks, separating each X-band data into two 75 Mbps I and Q channels, and transmitting the acquired wideband data through 75 Mbps LGS output ports to the LPS. The LGS receives Landsat 7 contact period schedules from the MOC. The LGS coordinates its operations with the LPS, in accordance with the Landsat 7 contact period schedules, for the receipt of raw wideband data by the LPS. The LPS receives all wideband data at real-time rates from the LGS. The LGS is required to receive Landsat 7 X-Band downlink data at elevation angles of 5 degrees. As a nominal, 6 contacts periods will be received on a daily basis. No single Landsat 7 spacecraft contact period is expected to exceed 14.03 minutes. The LGS also receives recorded ETM+ wideband data from supplemental Landsat 7 ground stations. The recorded ETM+ wideband data consists of the I and Q channel data for a single contact period. There may be an additional 4 or 5 contacts from supplemental ground stations per day. The LGS coordinates with the LPS to playback this data to the LPS. The LGS is designated to support Landsat 7 mission operations on a continuous basis, seven days a week, 24 hours a day. It is expected to support Landsat 7 system operations for a minimum mission life of 5 years. The operational support capabilities provided by the LGS include verification testing of the LGS functions and interfaces, hardware and software maintenance, and operator training.

3.2 LPS Description

The LPS is responsible for receiving the I and Q wideband data, in real-time, from four output channels of the LGS and storing them in its four wideband data stores, one per each LPS string. A total of 4 LPS strings are used to receive all data from the LGS. The LPS is also responsible for receiving the playbacks of recorded ETM+ wideband data, consisting of I and Q channel data for a contact period, from the LGS. The LPS uses two strings to receive and store the recorded I and Q data playbacks from the LGS. Each LPS string receives an I or Q channel wideband data at 75 Mbps rate, processes it at a rate equal to or greater than 7.5 Mbps rate, generates level 0R, browse, and metadata files (collectively called the LPS files), and makes them available for transfer to the EDC Distributed Active Archive Center (EDC DAAC), also located at the EDC. The LPS also provides a fifth string to be used as back up for its 4 primary strings. The LPS coordinates the receipt of ETM+ wideband

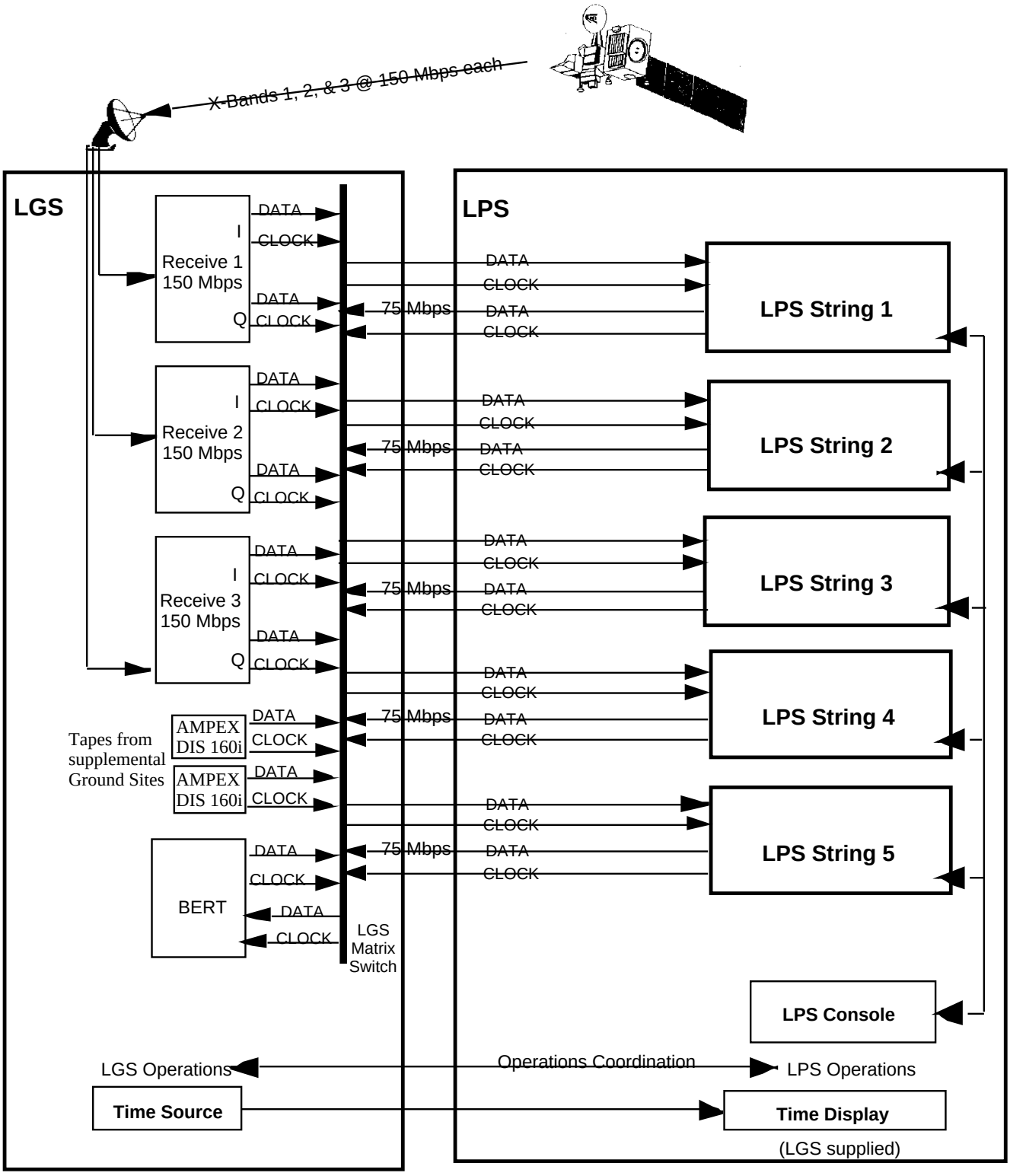


Figure 3-1: LGS-LPS Interface Block Diagram

data with the LGS in accordance with the Landsat 7 contact period schedules. The MOC makes these schedules available to the LPS in advance of the data receive time.

3.3 LGS-LPS Interface Overview

The Landsat 7 ETM+ wideband data, acquired by LGS in real-time, is transmitted to the LPS over 4 (two sets of I and Q) 75 Mbps channels. LPS receives the I and Q wideband data via the four 75 Mbps LGS output channels into its four wideband data stores, one each for its four independent strings. LPS uses the Landsat 7 contact period schedule, obtained from the MOC, to perform its data capture operations. LPS receives all wideband data from LGS on a Landsat 7 contact period basis. Once all wideband data from a scheduled Landsat 7 contact period has been received by the four (4) LPS strings, LPS informs LGS on the completion of data receive operations by LPS (before proceeding with Level 0R processing of the received data). The LPS also provides, via voice or FAX, a data receive summary to the MOC within 5 minutes of the completion of all data receive operations for the scheduled contact period.

LPS interfaces to LGS on an LPS string to LGS output channel basis. Each LPS string is responsible for receiving the Landsat 7 data (I or Q channel) from its associated LGS output channel. The full complement of the LGS-to-LPS interface, for the real-time ETM+ wideband data, consists of 4 LGS output channels and 4 LPS strings. Each LGS output channel is capable of transferring the acquired wideband data at the real-time rate of 75 Mbps. LPS also coordinates its operations with LGS to configure its fifth (spare) string with a five LGS output channels for back-up of either an LGS output channel or an LPS string. Each LPS string is also capable of sending test data, either generated by the LPS string or received from the LGS bit error rate tester (BERT), to the LGS.

Section 4 — Interface Requirements

This section presents detailed requirements for the interface between the LGS and the LPS.

4.1 LGS Interface Requirements

4.1.1 LGS Interface Functional Requirements

4.1.1.1 LGS shall provide the capability to transmit downlink wideband data in real time to LPS on a Landsat 7 contact period basis.

4.1.1.2 LGS shall provide the capability to transmit downlink wideband data to LPS via 5 LGS output channels. Each channel contains a serial data and clock pair.

4.1.1.3 LGS shall provide the capability to simultaneously transmit downlink wideband data via any 4 of the 5 LGS output channels.

4.1.1.4 LGS shall provide the capability to simultaneously transmit the downlink wideband data associated with a single Landsat 7 X-band operational downlink, to any 2 of the 5 LGS output channels. These 2 channels contain the I and Q data streams.

4.1.1.5 LGS shall provide the capability to receive a data channel from each LPS string (one serial data and clock pair per channel) for testing purposes.

4.1.1.6 LGS shall provide the capability to transmit bit error rate tester (BERT) data to the LPS, and to receive this same BERT data from LPS, for test purposes. CCSDS format is not required for this test data.

4.1.1.7 LGS shall provide the capability to receive test data from an LPS string and to loop back this test data through the matrix switch to any LPS string.

4.1.1.8 LGS shall provide a Coordinated Universal Time (UTC) display, for operator usage, to LPS. The numeric display format shall be DDD:HH:MM:SS where:

DDD = day of year (001 to 365, 366 in leap year)
HH = hours (00 to 23)
MM = minutes (00 to 59)
SS = seconds (00 to 59)

4.1.1.9 (Deleted per CCR LPS960131)

4.1.1.10 (Deleted per CCR LPS960131)

4.1.1.11 (Deleted per CCR LPS960131)

4.1.1.12 (Deleted per CCR LPS960131)

4.1.1.13 LGS shall playback the recorded ETM+ wideband data, received from supplemental Landsat 7 ground stations, to the LPS.

4.1.2 LGS Interface Operational Requirements

4.1.2.1 (Modified and moved to Section 4.1.1 per CCR LPS960092)

4.1.2.2 (Modified and moved to Section 4.1.1 per CCR LPS960092)

4.1.2.3 (Modified and moved to Section 4.1.1 per CCR LPS960092)

4.1.2.4 LGS shall provide the following default configurations, in accordance with which 2 of the 4 links are active:

a. Links 1 and 2 active: link 1 connects to LPS strings 1 and 2, link 2 to LPS strings 3 and 4.
b. Links 1 and 3 active: link 1 connects to LPS strings 1 and 2, link 3 to LPS strings 3 and 4.
c. Links 2 and 3 active: link 2 connects to LPS strings 1 and 2, link 3 to LPS strings 3 and 4.

4.1.2.5 (Deleted per CCR LPS960091)

4.1.2.6 LGS shall enable the serial clock signal when bit synchronizers are in lock.

4.1.2.7 LGS shall coordinate with LPS the switch over of an LGS output channel or the switch over of an LPS string , when necessary.

4.1.2.8 LGS shall coordinate interface fault isolation and recovery with LPS, when required.

4.1.2.9 LGS shall coordinate with LPS test data flows as required.

4.1.2.10 (Deleted per CCR LPS960131)

4.1.2.11 LGS shall coordinate the playback of the recorded ETM+ wideband data with the LPS.

4.1.2.12 LGS shall provide the following information regarding the recorded ETM+ wideband data to the LPS:

a. A three character identification code for the supplemental Landsat 7 ground station (e.g., ANC for recorded ETM+ data from Anchorage, Alaska ground station).

b. Receiving X-band link at the supplemental Landsat 7 ground station (1, 2, or 3).
c. LGS recorder playback outputs, I and Q channels, connecting to two LPS strings.

4.1.3 LGS Interface Performance Requirements

4.1.3.1 LGS shall transmit Landsat 7 downlink wideband data at a maximum rate of 75.0 (+ 2%) Mbps from each LGS output channel.

4.1.3.2 LGS shall transmit test data at a maximum rate of 75.0 (+ 2%) Mbps from each LGS output channel.

4.1.3.3 LGS shall receive test data at a maximum rate of 75.0 (+ 2%) Mbps from LPS.

4.1.3.4 LGS shall provide the capability to transmit all the downlink wideband data for each Landsat 7 contact. Contact periods of up to 14.03 minutes are expected. The 16 day contact opportunities for 0, 3, and 5 degree acquisition circles are provided in Appendix A.

4.1.4 LGS Interface Design Requirements

4.1.4.1 LGS shall use non-return to zero-level (NRZ-L) synchronous clock and data signals for transmitting serial data to LPS. The NRZ-L signal format is shown in Figure 4-1. Data transitions occur on the rising edge of clock (A).

4.1.4.2 LGS shall receive non-return to zero-level (NRZ-L) synchronous clock and data signals from LPS.

4.1.4.3 LGS shall use differential coax ECL (F100k or equivalent) circuit configuration to transmit serial data and clock signals to LPS.

4.1.4.4 LGS shall use differential coax ECL (F100k or equivalent) circuit configuration to receive serial data and clock signals from LPS.

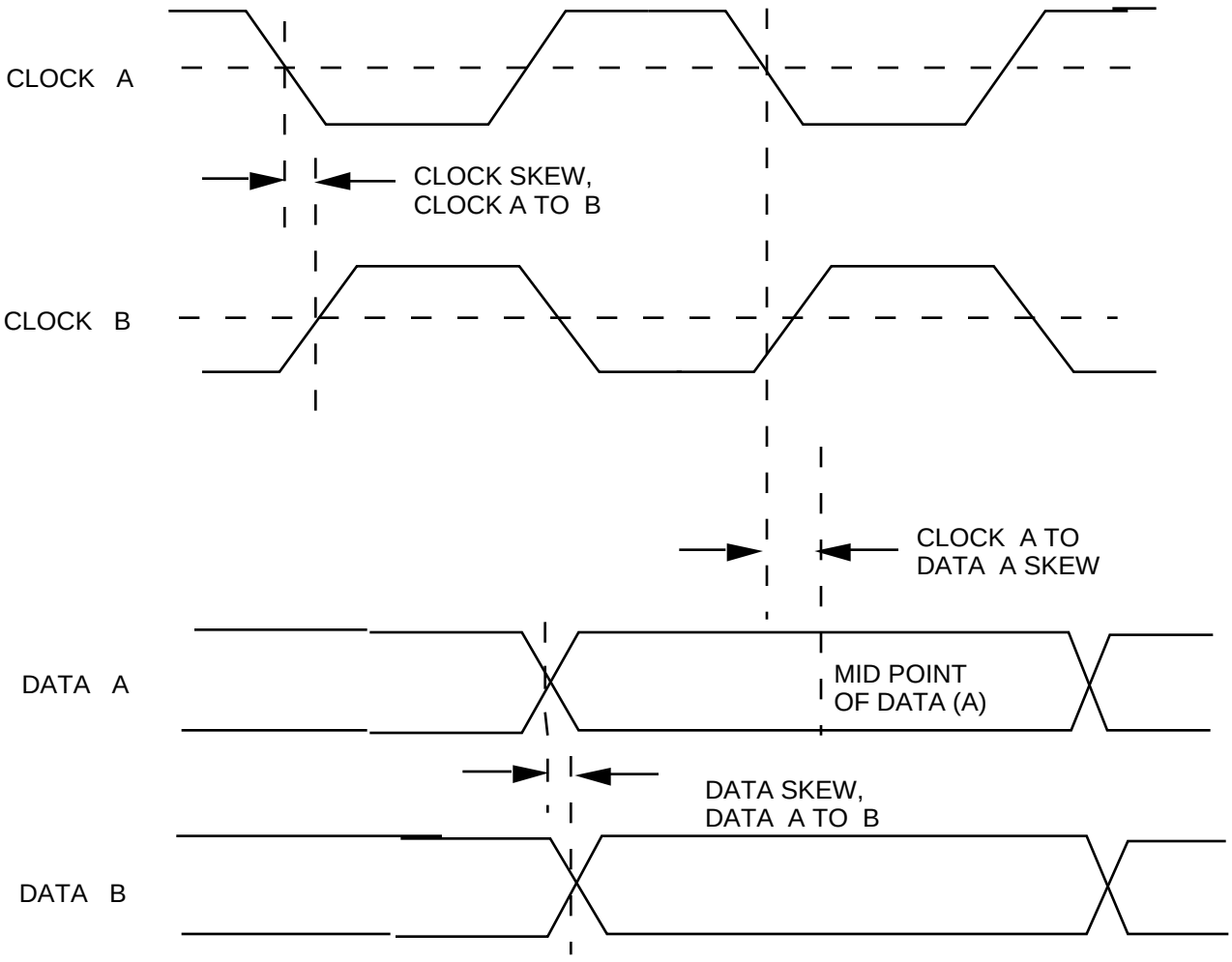


Figure 4-1: NRZ-L Signal Format

4.1.4.5 LGS shall terminate each serial data and clock cable at each LPS input using a UG -88 connector or equivalent.

4.1.4.6 LGS shall use RG-223 coax cable (or equivalent) to transmit or receive serial ECL data and clock signals; cables lengths shall not exceed 50.0 feet.

4.1.4.7 LGS shall provide cables that have less than 0.60 nanosecond (ns) skew between clock (A) and clock (B). See Figure 4-1.

4.1.4.8 LGS shall provide cables that have less than 0.60 ns skew between data (A) and data (B). See Figure 4-1.

4.1.4.9 LGS shall provide cables that have less than 25% of a period skew between data (A) and clock (A). This skew shall include the combined effects of propagation delay and phase instability (phase jitter). See Figure 4-1.

4.1.4.10 LGS shall provide a serial clock that has a duty cycle asymmetry of less than 20 %.

4.1.4.11 LGS shall provide serial data and clock signals that meet a BER of 10^{-9} on each channel when looped back at LPS.

4.2 LPS Interface Requirements

4.2.1 LPS Interface Functional Requirements

4.2.1.1 LPS shall provide the capability to receive downlink wideband data in real time from LGS on a Landsat 7 contact period basis.

4.2.1.2 LPS shall provide the capability to receive downlink wideband data from LGS, via 5 LGS output channels. Each channel contains a serial data and clock pair.

4.2.1.3 LPS shall provide the capability to simultaneously receive downlink wideband data via any 4 of the 5 LGS output channels.

4.2.1.4 LPS shall provide the capability to simultaneously receive the downlink wideband data associated with a single Landsat 7 X-band operational downlink, from any 2 of the 5 LGS output channels. These 2 channels contain the I and Q data streams.

4.2.1.5 LPS shall provide the capability to transmit a test data output from each LPS string (one serial data and clock pair per channel) to LGS for testing purposes.

4.2.1.6 LPS shall provide the capability to receive bit error rate tester (BERT) data from LGS, and retransmit this same BERT data to LGS, for test purposes.

4.2.1.7 LPS shall provide the capability to transmit test data from an LPS string to LGS and to receive this test data via a loop back through the matrix switch at the LGS.

4.2.1.8 (Deleted per CCR LPS960131)

4.2.1.9 LPS shall provide the capability to receive the I and Q channel playback of recorded ETM+ wideband data from LGS.

4.2.2 LPS Interface Operational Requirements

4.2.2.1 (Deleted per CCR LPS960131)

4.2.2.2 LPS shall comply with the default configuration described in 4.1.2.4.

4.2.2.3 LPS shall coordinate with LGS the switch over of an LGS output channel or the switch over of an LPS string , when necessary.

4.2.2.4 LPS shall coordinate interface fault isolation and recovery with LGS, when required.

4.2.2.5 LPS shall coordinate with LGS test data flows as required.

4.2.2.6 LPS shall coordinate the receipt of recorded ETM+ wideband data, consisting of I and Q channel data, with LGS.

4.2.3 LPS Interface Performance Requirements

4.2.3.1 Each LPS string shall receive Landsat 7 downlink wideband data at a maximum rate of 75.0 (+ 2%) Mbps from an LGS output channel.

4.2.3.2 Each LPS string shall receive test data at a maximum rate of 75.0 (+ 2%) Mbps from an LGS output channel.

4.2.3.3 Each LPS string shall transmit test data at a maximum rate of 75.0 (+ 2%) Mbps to an LGS input channel.

4.2.3.4 LPS shall provide the capability to receive all the downlink wideband data from each Landsat 7 contact. Contact periods of up to 14.03 minutes are expected. The 16 day contact opportunities for 0, 3, and 5 degree acquisition circles are provided in Appendix A.

4.2.4 LPS Interface Design Requirements

4.2.4.1 LPS shall use non-return to zero-level (NRZ-L) synchronous clock and data signals for receiving serial data from LGS. The NRZ-L signal format is shown in Figure 4-1. Data transitions occur on the rising edge of clock (A).

4.2.4.2 LPS shall use non-return to zero-level (NRZ-L) synchronous clock and data signals for transmitting serial data to LGS.

4.2.4.3 LPS shall use differential coax ECL (F100k or equivalent) circuit configuration to transmit serial data and clock signals to LGS.

4.2.4.4 LPS shall use differential coax ECL (F100k or equivalent) circuit configuration to receive serial data and clock signals from LGS.

4.2.4.5 LPS shall provide cable connections that are compatible with UG-88 connectors of the serial data and clock cables.

4.2.4.6 LPS shall receive a serial clock from LGS that complies with the specifications included in 4.1.4.7 through 4.1.4.11

Appendix A

This appendix contains 0 degree, 3 degree and 5 degree acquisition circle results computed for EDC for a 16 day cycle. These results illustrate the expected durations of the contact periods received at EDC. Softcopies of these results are contained in PDF files (Acrobat readable) and provided along with the file for this ICD. Upon request, hardcopies of the 0 degree, 3 degree and 5 degree acquisition circle results (10 pages of Tables) can also be supplied by the Landsat 7 Processing System Project.

EDC 0 Degree Acquisition Circle

16 Day Contact Schedule

Downlink lockup time prior to and after scenes are available 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Duration Min. Downlink	Station	Begin Path	Total Duration minutes	Max Scenes Per Day 2 Downlinks	Total Downlink Time	Real-Time Downlink Time
1	102	211	231	20.0	7.96	EDC		7.96			
	118	199	233	34.1	13.59	EDC		13.59			
	134	197	229	31.6	12.59	EDC		12.59			
	13	17	44	26.4	10.54	EDC		10.54			
	29	12	47	35.1	13.98	EDC		13.98			
	45	11	38	26.9	10.73	EDC		10.73			
									348.1		
	First	Rev	Path		1	70				69.39	24.52
2	109	204	233	28.7	11.44	EDC		11.44			
	125	197	232	34.9	13.93	EDC		13.93			
	141	202	225	23.3	9.29	EDC		9.29			
	20	14	47	32.9	13.11	EDC		13.11			
	36	11	45	33.4	13.32	EDC		13.32			
	52	13	30	16.4	6.52	EDC		6.52			
									339.1		
	First	Rev	Path		16	77				67.61	26.43
3	100	214	230	16.0	6.39	EDC		6.39			
	116	199	233	33.3	13.28	EDC		13.28			
	132	197	230	32.9	13.10	EDC		13.10			
	11	19	42	23.3	9.30	EDC		9.30			
	27	12	47	35.1	13.98	EDC		13.98			
	43	11	40	28.9	11.51	EDC		11.51			
									338.9		
	First	Rev	Path		31	84				67.56	23.28
4	107	206	233	26.7	10.64	EDC		10.64			
	123	197	232	35.0	13.95	EDC		13.95			
	139	200	227	26.5	10.55	EDC		10.55			
	18	15	47	31.6	12.60	EDC		12.60			
	34	11	46	34.2	13.65	EDC		13.65			
	50	12	33	20.2	8.05	EDC		8.05			
									348.3		
	First	Rev	Path		45	75				69.44	34.30

EDC 0 Degree Acquisition Circle

16 Day Contact Schedule

Downlink lockup time prior to and after scenes are available 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Duration Min. Downlink	Station	Begin Path	Total Duration minutes	Max Scenes Per Day 2 Downlinks	Total Downlink Time	Real-Time Downlink Time
5	98	218	229	10.4	4.15	EDC		4.15			
	114	201	233	32.3	12.89	EDC		12.89			
	130	197	231	33.8	13.47	EDC		13.47			
	146	210	217	7.0	2.78	EDC		2.78			
	9	21	40	19.1	7.62	EDC		7.62			
	25	13	48	34.8	13.89	EDC		13.89			
	41	11	42	30.5	12.17	EDC		12.17			
									335.9		
	First	Rev	Path		60	82				66.97	7.62
6	105	208	232	24.4	9.72	EDC		9.72			
	121	197	232	34.8	13.88	EDC		13.9			
	137	199	228	28.9	11.51	EDC		11.5			
	16	16	46	29.9	11.93	EDC		11.9			
	32	11	46	34.8	13.86	EDC		13.9			
	48	12	35	23.3	9.31	EDC		9.31			
									352.2		
	First	Rev	Path		74	73				70.21	35.10
7	112	202	233	31.0	12.37	EDC		12.37			
	128	197	231	34.4	13.73	EDC		13.73			
	144	206	222	16.3	6.50	EDC		6.50			
	7	24	37	12.7	5.06	EDC		5.06			
	23	13	48	34.3	13.67	EDC		13.67			
	39	11	43	31.9	12.72	EDC		12.72			
	55	16	23	6.8	2.73	EDC		2.73			
									335.0		
	First	Rev	Path		89	80				66.78	18.73
8	103	210	232	21.5	8.58	EDC		8.58			
	119	198	233	34.4	13.70	EDC		13.70			
	135	198	229	30.8	12.27	EDC		12.27			
	14	17	45	27.8	11.09	EDC		11.09			
	30	12	47	35.1	13.98	EDC		13.98			
	46	11	37	25.9	10.31	EDC		10.31			
									350.8		
	First	Rev	Path		103	71				69.93	35.38

EDC 0 Degree Acquisition Circle

16 Day Contact Schedule

Downlink lockup time prior to and after scenes are available 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Duration Min. Downlink	Station	Begin Path	Total Duration minutes	Max Scenes Per Day 2 Downlinks	Total Downlink Time	Real-Time Downlink Time
9	110	203	233	29.5	11.77	EDC		11.77			
	126	197	232	34.8	13.88	EDC		13.88			
	142	203	224	21.4	8.52	EDC		8.52			
	21	14	47	33.5	13.36	EDC		13.36			
	37	11	44	33.0	13.17	EDC		13.17			
	53	14	28	14.1	5.61	EDC		5.61			
									332.6		
	First	Rev	Path		118	78				66.31	26.53
10	101	213	231	18.0	7.19	EDC		7.19			
	117	199	233	33.7	13.43	EDC		13.43			
	133	197	230	32.3	12.86	EDC		12.86			
	12	18	43	25.1	10.01	EDC		10.01			
	28	12	47	35.2	14.03	EDC		14.03			
	44	11	39	28.1	11.19	EDC		11.19			
									344.6		
	First	Rev	Path		133	85				68.71	24.04
11	108	205	233	27.7	11.04	EDC		11.04			
	124	197	232	35.0	13.94	EDC		13.94			
	140	201	226	25.0	9.95	EDC		9.95			
	19	14	47	32.4	12.91	EDC		12.91			
	35	11	45	34.0	13.54	EDC		13.54			
	51	13	31	18.6	7.40	EDC		7.40			
									345.0		
	First	Rev	Path		147	76				68.78	26.45
12	99	216	230	13.5	5.38	EDC		5.38			
	115	200	233	32.9	13.10	EDC		13.10			
	131	197	230	33.3	13.28	EDC		13.28			
	10	20	41	21.5	8.58	EDC		8.58			
	26	12	48	35.1	14.00	EDC		14.00			
	42	11	41	29.8	11.89	EDC		11.89			
									332.2		
	First	Rev	Path		162	83				66.23	22.58

EDC 0 Degree Acquisition Circle

16 Day Contact Schedule

Downlink lockup time prior to and after scenes are available 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Duration Min. Downlink	Station	Begin Path	Total Duration minutes	Max Scenes Per Day 2 Downlinks	Total Downlink Time	Real-Time Downlink Time
13	106	207	233	25.6	10.21	EDC		10.21			
	122	197	232	34.9	13.93	EDC		13.93			
	138	199	227	27.7	11.06	EDC		11.06			
	17	15	46	30.7	12.26	EDC		12.26			
	33	11	46	34.4	13.73	EDC		13.73			
	49	12	34	21.8	8.68	EDC		8.68			
									350.5		
	First	Rev	Path		176	74				69.87	34.67
14	97	221	227	5.9	2.37	EDC		2.37			
	113	201	233	31.8	12.66	EDC		12.66			
	129	197	231	34.2	13.64	EDC		13.64			
	145	207	220	12.7	5.08	EDC		5.08			
	8	22	38	16.2	6.44	EDC		6.44			
	24	13	48	34.5	13.75	EDC		13.75			
	40	11	42	31.2	12.43	EDC		12.43			
									332.9		
	First	Rev	Path		191	81				66.37	6.44
15	104	209	232	23.0	9.18	EDC		9.18			
	120	198	233	34.7	13.82	EDC		13.82			
	136	198	228	30.0	11.95	EDC		11.95			
	15	16	45	28.9	11.51	EDC		11.51			
	31	12	47	34.8	13.89	EDC		13.89			
	47	12	36	24.5	9.78	EDC		9.78			
									351.8		
	First	Rev	Path		205	72				70.13	35.18
16	111	203	233	30.3	12.10	EDC		12.10			
	127	197	231	34.7	13.83	EDC		13.83			
	143	204	223	19.1	7.62	EDC		7.62			
	6	27	33	6.8	2.70	EDC		2.70			
	22	14	47	33.8	13.49	EDC		13.49			
	38	11	44	32.4	12.92	EDC		12.92			
	54	15	26	10.9	4.33	EDC		4.33			
									336.0		
	First	Rev	Path		220	79				66.99	2.70

Average Scenes Per Day	342.11	Total Maximum Scenes for 16 Days	5473.8
Minimum Pass Duration	2.37	Maximum Pass Duration	14.03

3 Degree Acquisition Circle

EDC 16 Day Contact Schedule

Downlink lockup time prior to and after scenes are : 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Begin Rev	Begin Path	Total Duration minutes	GMT Start	GMT End	Max Scenes Per Day	Total Downlink Time	Real-Time Downlink Time
1	102	216	227	11.8			4.69	1:46:47	1:51:28			
	118	201	231	30.1			12.00	3:19:41	3:31:41			
	134	200	227	27.1			10.80	4:58:10	5:08:58			
	13	20	41	20.7			8.25	15:18:35	15:26:50			
	29	14	45	31.2			12.44	16:55:05	17:07:31			
	45	14	36	21.6			8.62	18:33:58	18:42:35	284.9		
					1	70					56.80	29.31
2	109	207	230	23.8			9.50	2:26:27	2:35:57			
	125	199	230	31.1			12.39	4:02:09	4:14:32			
	141	205	222	16.4			6.54	5:43:25	5:49:57			
	20	16	45	28.6			11.41	16:00:15	16:11:40			
	36	13	43	29.4			11.72	17:37:56	17:49:39			
										258.6		
					16	77					51.56	23.13
3	116	202	231	29.2			11.65	3:07:43	3:19:22			
	132	199	228	28.6			11.40	4:45:24	4:56:48			
	11	22	39	16.3			6.51	15:07:01	15:13:32			
	27	14	45	31.2			12.43	16:42:43	16:55:09			
	43	14	38	24.0			9.58	18:21:36	18:31:11			
										258.7		
					31	84					51.57	28.52
4	107	209	230	21.4			8.53	2:14:53	2:23:25			
	123	199	230	31.1			12.41	3:49:47	4:02:12			
	139	203	224	20.7			8.24	5:30:16	5:38:30			
	18	17	44	27.1			10.79	15:48:17	15:59:04			
	34	13	44	30.3			12.07	17:25:35	17:37:39			
	50	16	29	12.3			4.92	19:05:39	19:10:34	285.7		
					45	75					56.96	27.78
5	114	203	231	28.1			11.21	2:55:45	3:06:58			
	130	199	228	29.7			11.85	4:33:03	4:44:54			
	9	26	35	9.2			3.67	14:56:15	14:59:55			
	25	15	46	30.9			12.31	16:30:45	16:43:04			
	41	13	39	26.0			10.37	18:08:50	18:19:12			
										247.8		
					60	82					49.41	26.35
6	105	211	229	18.3			7.30	2:03:19	2:10:37			
	121	199	230	30.9			12.32	3:37:25	3:49:44			
	137	201	225	23.8			9.48	5:17:06	5:26:35			
	16	18	43	25.1			9.99	15:36:20	15:46:19			
	32	13	44	30.8			12.30	17:13:13	17:25:31			
	48	15	32	17.0			6.76	18:52:54	18:59:40	291.7		
					74	73					58.15	29.05

3 Degree Acquisition Circle

EDC 16 Day Contact Schedule

Downlink lockup time prior to and after scenes are : 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Begin Rev	Begin Path	Total Duration minutes	GMT Start	GMT End	Max Scenes Per Day	Total Downlink Time	Real-Time Downlink Time
7	112	204	231	26.6			10.62	2:43:48	2:54:25			
	128	199	229	30.4			12.14	4:20:41	4:32:49			
	23	15	46	30.2			12.05	16:18:24	16:30:27			
	39	13	41	27.6			11.01	17:56:29	18:07:30			
										229.8		
					89	80					45.82	23.06
8	103	214	228	14.4			5.75	1:52:10	1:57:55			
	119	200	231	30.4			12.13	3:25:28	3:37:36			
	135	200	226	26.1			10.41	5:04:21	5:14:46			
	14	20	42	22.4			8.93	15:24:46	15:33:42			
	30	14	45	31.2			12.45	17:01:15	17:13:42			
	46	14	35	20.3			8.08	18:40:08	18:48:13	289.7		
					103	71					57.75	29.46
9	110	206	231	24.8			9.90	2:32:14	2:42:08			
	126	199	230	30.9			12.32	4:08:19	4:20:38			
	142	207	220	13.4			5.33	5:50:24	5:55:44			
	21	16	45	29.3			11.68	16:06:26	16:18:07			
	37	13	42	28.9			11.54	17:44:07	17:55:39			
										254.7		
					118	78					50.77	23.22
10	101	218	226	8.2			3.27	1:41:24	1:44:40			
	117	201	231	29.7			11.83	3:13:30	3:25:20			
	133	199	227	27.9			11.12	4:51:35	5:02:42			
	12	21	40	18.9			7.52	15:12:48	15:20:19			
	28	14	45	31.3			12.49	16:48:54	17:01:23			
	44	14	37	23.0			9.18	18:27:47	18:36:58	277.9		
					133	85					55.41	29.19
11	108	208	230	22.6			9.02	2:20:40	2:29:41			
	124	199	230	31.1			12.41	3:55:58	4:08:23			
	140	204	223	18.7			7.47	5:36:51	5:44:19			
	19	17	45	28.0			11.16	15:54:28	16:05:38			
	35	13	43	30.0			11.95	17:31:45	17:43:42			
	51	18	27	9.1			3.64	19:12:38	19:16:16	279.1		
					147	76					55.65	26.75
12	115	202	231	28.7			11.43	3:01:32	3:12:58			
	131	199	228	29.2			11.63	4:39:14	4:50:52			
	10	24	37	13.6			5.41	15:01:38	15:07:03			
	26	14	46	31.1			12.42	16:36:32	16:48:57			
	42	13	39	25.2			10.03	18:15:01	18:25:03			
										255.4		
					162	83					50.92	27.86

3 Degree Acquisition Circle

EDC 16 Day Contact Schedule

Downlink lockup time prior to and after scenes are : 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Begin Rev	Begin Path	Total Duration minutes	GMT Start	GMT End	Max Scenes Per Day	Total Downlink Time	Real-Time Downlink Time
13	106	210	230	20.0			7.96	2:09:06	2:17:04			
	122	199	230	31.0			12.37	3:43:36	3:55:58			
	138	202	224	22.3			8.91	5:23:41	5:32:36			
	17	18	44	26.1			10.39	15:42:30	15:52:53			
	33	13	44	30.5			12.17	17:19:24	17:31:34			
	49	16	30	14.6			5.83	18:59:29	19:05:19	289.1		
					176	74					57.63	28.39
14	113	203	231	27.5			10.95	2:49:35	3:00:32			
	129	199	229	30.2			12.04	4:26:52	4:38:54			
	24	15	46	30.5			12.16	16:24:34	16:36:44			
	40	13	40	26.8			10.67	18:02:40	18:13:20			
										229.8		
					191	81					45.82	22.83
15	104	212	229	16.6			6.60	1:57:33	2:04:09			
	120	200	231	30.7			12.26	3:31:39	3:43:55			
	136	201	226	25.1			10.02	5:10:55	5:20:56			
	15	19	43	23.8			9.47	15:30:33	15:40:01			
	31	14	45	31.0			12.35	17:07:26	17:19:47			
	47	15	33	18.6			7.41	18:46:43	18:54:08	291.5		
					205	72					58.11	29.23
16	111	205	231	25.8			10.29	2:38:01	2:48:18			
	127	198	229	30.7			12.26	4:14:06	4:26:22			
	143	209	218	9.3			3.70	5:57:23	6:01:05			
	22	16	45	29.7			11.84	16:12:37	16:24:27			
	38	13	41	28.2			11.25	17:50:18	18:01:33			
										247.5		
					220	79					49.34	23.09

Total Maximum Scenes for 16 Days 4024.5

Average Scenes Per Day 251.5

	Contact Durations	Total Downlink Time	Real-Time Downlink Time	Scenes Per Day
Min	3.27	45.82	22.83	229.83
Max	12.49	58.15	29.46	291.68

5 Degree Acquisition Circle

EDC 16 Day Contact Schedule

Downlink lockup time prior to and after scenes : 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Begin Rev	Begin Path	Total Duration min.	GMT Start	GMT End	Max Scenes Per Day	Total Downlink Time	Real-Time Downlink Time
1	118	202	230	27.7			11.05	3:20:05	3:31:08			
	134	201	225	24.2			9.66	4:58:34	5:08:14			
	13	22	39	16.6			6.63	15:19:23	15:26:01			
	29	15	44	28.9			11.51	16:55:28	17:06:59			
	45	16	34	18.1			7.22	18:34:45	18:41:58			
										231.1		
					1	70					46.07	25.36
2	109	208	229	20.7			8.25	2:26:51	2:35:06			
	125	200	229	28.7			11.46	4:02:33	4:14:01			
	141	208	219	10.9			4.36	5:44:37	5:48:59			
	20	18	44	26.0			10.36	16:01:03	16:11:25			
	36	14	41	26.9			10.72	17:38:20	17:49:03			
										226.5		
					16	77					45.15	21.08
3	116	203	230	26.8			10.67	3:08:07	3:18:47			
	132	200	227	25.9			10.34	4:45:48	4:56:08			
	11	25	36	10.7			4.27	15:08:13	15:12:29			
	27	15	44	28.8			11.49	16:43:07	16:54:36			
	43	15	36	20.9			8.33	18:22:00	18:30:20	226.2		
					31	84					45.10	24.09
4	107	210	228	17.8			7.09	2:15:17	2:22:22			
	123	200	229	28.8			11.48	3:50:11	4:01:40			
	139	205	222	16.8			6.68	5:31:04	5:37:45			
	18	19	43	24.3			9.68	15:49:05	15:58:46			
	34	14	42	27.8			11.10	17:25:59	17:37:05			
	50	21	24	3.1			1.25	19:07:39	19:08:54	237.2		
					45	75					47.28	22.03
5	114	204	230	25.5			10.15	2:56:09	3:06:18			
	130	200	227	27.2			10.83	4:33:27	4:44:17			
	25	16	44	28.4			11.34	16:31:09	16:42:29			
	41	15	38	23.2			9.24	18:09:38	18:18:52	208.5		
					60	82					41.56	20.58
6	105	213	227	14.0			5.59	2:04:07	2:09:42			
	121	201	229	28.5			11.38	3:38:13	3:49:36			
	137	203	223	20.5			8.16	5:17:54	5:26:04			
	16	20	42	22.0			8.77	15:37:07	15:45:53			
	32	15	43	28.5			11.37	17:14:01	17:25:23			
	48	17	30	12.1			4.82	18:53:42	18:58:31	251.3		
					74	73					50.09	24.96

5 Degree Acquisition Circle

EDC 16 Day Contact Schedule

Downlink lockup time prior to and after scenes : 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Begin Rev	Begin Path	Total Duration min.	GMT Start	GMT End	Max Scenes Per Day	Total Downlink Time	Real-Time Downlink Time
7	112	205	229	23.9			9.52	2:44:12	2:53:43			
	128	200	228	28.0			11.18	4:21:05	4:32:16			
	23	16	44	27.8			11.08	16:18:47	16:29:52			
	39	14	39	25.0			9.96	17:56:53	18:06:51	209.4		
					89	80					41.74	21.04
8	103	217	225	8.0			3.20	1:53:21	1:56:33			
	119	201	229	28.0			11.18	3:25:52	3:37:03			
	135	202	225	23.1			9.22	5:05:09	5:14:22			
	14	21	40	18.8			7.51	15:25:10	15:32:41			
	30	15	44	28.9			11.51	17:01:39	17:13:10			
	46	16	33	16.5			6.57	18:40:56	18:47:30	246.7		
					103	71					49.19	25.59
9	110	207	229	21.8			8.71	2:32:38	2:41:21			
	126	200	228	28.6			11.39	4:08:43	4:20:06			
	142	211	216	5.5			2.19	5:52:00	5:54:11			
	21	17	44	26.8			10.67	16:06:50	16:17:30			
	37	14	41	26.4			10.52	17:44:31	17:55:02	218.1		
					118	78					43.48	21.19
10	117	202	230	27.3			10.87	3:13:54	3:24:46			
	133	201	226	25.1			10.00	4:52:23	5:02:23			
	12	24	38	14.3			5.70	15:14:00	15:19:42			
	28	15	44	29.0			11.56	16:49:18	17:00:52			
	44	15	35	19.7			7.84	18:28:11	18:36:01			
										230.6		
					133	85					45.97	25.10
11	108	209	229	19.3			7.71	2:21:04	2:28:47			
	124	200	229	28.8			11.48	3:56:22	4:07:51			
	140	206	220	14.2			5.66	5:37:38	5:43:18			
	19	18	43	25.3			10.10	15:54:52	16:04:58			
	35	14	42	27.5			10.96	17:32:09	17:43:07			
										230.3		
					147	76					45.91	21.06
12	115	203	230	26.1			10.42	3:01:56	3:12:21			
	131	200	227	26.6			10.60	4:39:37	4:50:13			
	10	28	33	5.4			2.16	15:03:14	15:05:24			
	26	16	44	28.8			11.47	16:37:20	16:48:48			
	42	15	37	22.2			8.86	18:15:49	18:24:41	218.2		
					162	83					43.51	22.49

5 Degree Acquisition Circle

EDC 16 Day Contact Schedule

Downlink lockup time prior to and after scenes : 0 seconds

Cycle Day	Path	Start Row	End Row	Avail. Scenes Per Downlink	Begin Rev	Begin Path	Total Duration min.	GMT Start	GMT End	Max Scenes Per Day	Total Downlink Time	Real-Time Downlink Time
13	106	212	228	16.1			6.40	2:09:54	2:16:18			
	122	200	229	28.7			11.44	3:44:00	3:55:26			
	138	204	223	18.8			7.48	5:24:29	5:31:58			
	17	19	42	23.1			9.21	15:42:54	15:52:07			
	33	15	43	28.1			11.21	17:20:12	17:31:25			
	49	19	27	8.6			3.43	19:00:40	19:04:06	246.6		
					176	74					49.17	23.85
14	113	205	229	24.8			9.87	2:50:22	3:00:14			
	129	200	228	27.7			11.04	4:27:16	4:38:18			
	24	16	44	28.1			11.19	16:24:58	16:36:09			
	40	15	39	24.0			9.58	18:03:27	18:13:02	209.1		
					191	81					41.68	20.77
15	104	215	226	11.5			4.60	1:58:44	2:03:20			
	120	201	229	28.4			11.31	3:32:02	3:43:21			
	136	202	224	21.9			8.74	5:11:19	5:20:03			
	15	21	41	20.4			8.12	15:31:21	15:39:28			
	31	15	43	28.6			11.42	17:07:50	17:19:15			
	47	17	31	14.3			5.69	18:47:31	18:53:12	250.2		
					205	72					49.88	25.23
16	111	206	229	23.0			9.16	2:38:25	2:47:35			
	127	200	228	28.4			11.32	4:14:54	4:26:13			
	22	17	44	27.3			10.87	16:13:01	16:23:53			
	38	14	40	25.7			10.23	17:50:42	18:00:56			
										208.6		
					220	79					41.58	21.10

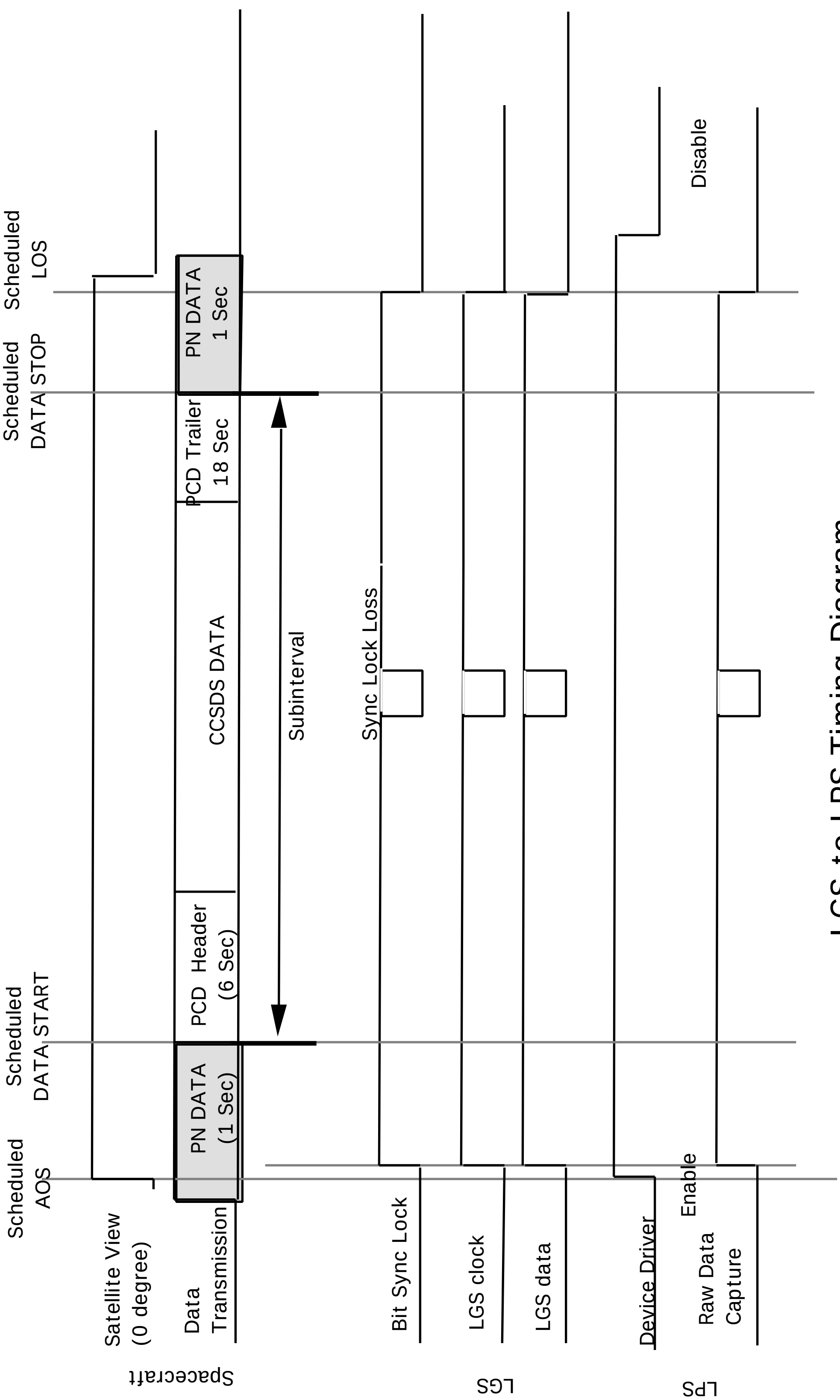
Total Maximum Scenes for 16 Days 3648.4

228.0

	Contact Durations	Total Downlink Time	Real-Time Downlink Time	Scenes Per Day
Min	1.25	41.56	20.58	208.46
Max	11.56	50.09	25.59	251.25

Appendix B

This appendix contains a timing diagram that depicts the raw wideband data transfer interface (handshake) between the LGS and the LPS. The diagram is provided on the next page.



LGS to LPS Timing Diagram

Assumptions:
- LGS clock enabled at scheduled AOS and disabled at scheduled LOS
- Bit sync lock loss suspends LPS capture

Scenario
- The LPS raw data capture is enabled prior to scheduled AOS
- PN and CCSDS are captured

Glossary

Bit Error Rate (BER): The number of binary digits (bits) received in error divided by the total number of bits received over a specified time period.

Bit Error Rate Tester (BERT): Test equipment used to generate and receive test data for the purposes of measuring the BER.

Landsat 7 Contact Period: The time duration between the start and end of wideband data transmissions from the Landsat 7 spacecraft to a ground station.

LGS Output Channel: A serial clock and data pair that contains either an I or Q data stream.

LPS String: A functional entity of the LPS responsible for end-to-end processing of the raw wideband data received from a downlink channel (I or Q) of the X-band downlink data captured by the LGS.

Downlink wideband data: Mission Data originating on a spacecraft for transmission to the ground.

Acronym List

AOS	Acquisition of Signal
BER	Bit Error Rate
BERT	Bit Error Rate Tester
CCB	Configuration Control Board
CCSDS	Consultative Committee on Space Data System
DCN	Document Change Notice
ECL	emitter coupled logic
EDC	EROS Data Center
EDC DAAC	EDC Distributed Active Archive Center
EROS	Earth Resources Observation System
ETM+	Enhanced Thematic Mapper plus
F&PS	Functional and Performance Specification
GSFC	Goddard Space Flight Center
I	in-phase signal component
ICD	Interface Control Document
IPD	Information Processing Division
LAN	Local area network
LGS	Landsat 7 Ground Station
LOS	Loss of signal
LPS	Landsat 7 Processing System
Mbps	megabits per second
MOC	Mission Operations Center
MO&DSD	Mission Operations and Data Systems Directorate
NASA	National Aeronautics and Space Administration
NRZ-L	non-return to zero-level
Q	quadrature signal component
UTC	Coordinated Universal Time